Mark IVB Current and Next Upgrades

and

Using Multispectral Imagery to Highlight Low, Warm Features in the Tropics at Night

Stan Turner
(On behalf of Rick Anstett)

610 354 1560
stanley.d.turner@lmco.com
richard.a.anstett@lmco.com

Overview of:

The Current MARKIVB System Upgrades and New Features
   Windows Data Servers

The next upgrade
   Windows Ingest Server
   X-Band

Multispectral Imagery that may be helpful to the JTWC mission

- **Phase I: UNIX Ingest-Windows Data Servers**
  - ❖ **Ingest system is remains UNIX-based**
  - ❖ **Introduces two Windows Servers to support client requests**
    - **The two new servers are much faster than the 2000-era UNIX server**
    - **The servers offer two Areas of Interest (AOIs)**
    - **The servers offer Projected MSIs**

  - ❖ **Note: Full capabilities are available using the 11.10.030X client application**
    - ❖ **Currently at AFCAin iTRM approval.**

Mark IVB Build 11.10.0205/0303

Two Projected Area Of Interests

Animation Zoom improvements

Animation High Resolution Retrieve

Geostationary ingest on tracking antenna.

Continuous Listen satellite signal collection, augments detailed schedule mode.

Added 'Geographic' Projection (Google Earth - Falconview)

Projected Multispectral Imagery (MSI)

Project 12 Meteosat Second Generation channels

Client Applications compatible with **Windows Vista**

Sun Corrected POES.
Sun correction previously only on GEO visible channels and MSIs.

Day Night Visual Indicator

Image Navigation provides feedback

Black Background for inserted Image Text

Command String Handbook added to Help menu

Command String editing improvements

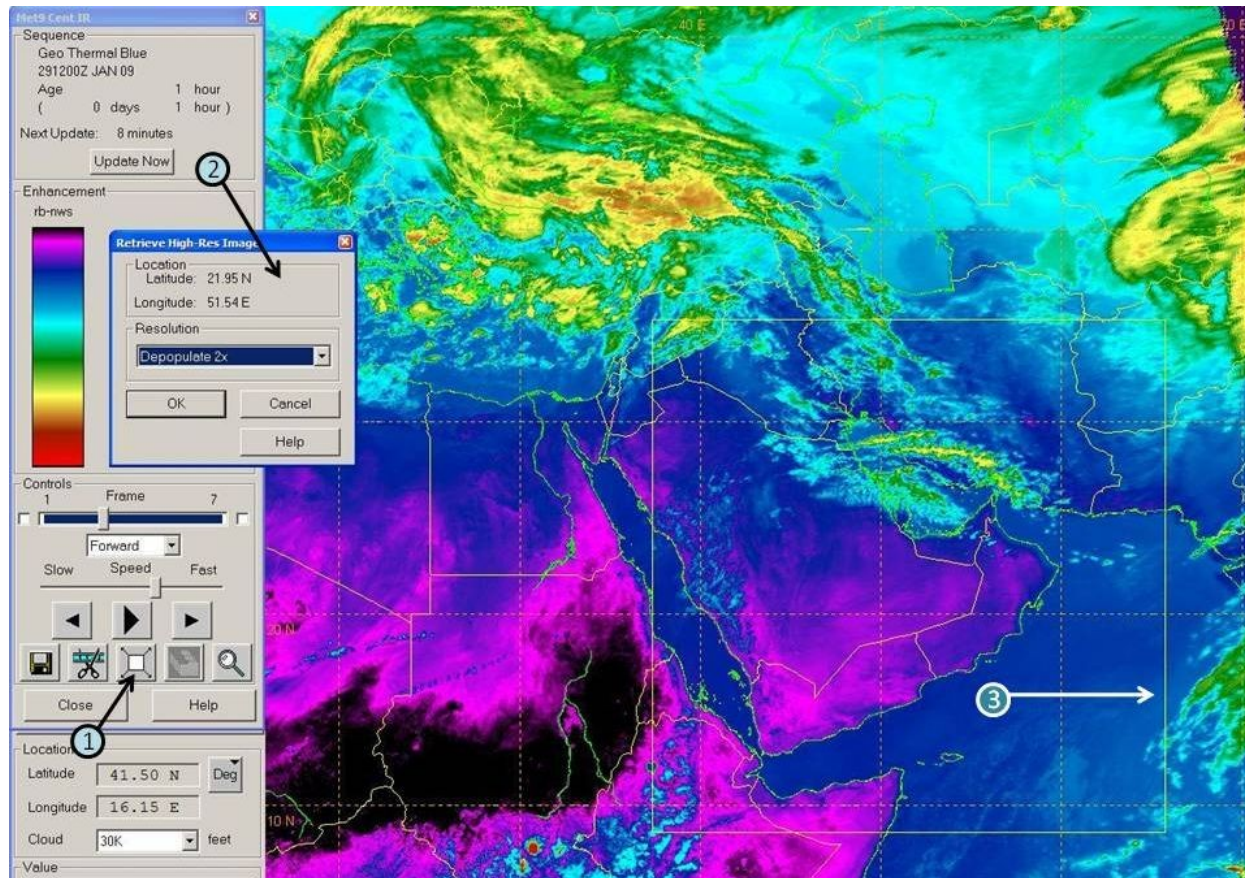New Satellites
Feng Yun 2E (position 123 E)
NOAA 19
GOES 14
DMSP F18

Example: Improved High-Res Retrieve

The animation high-resolution retrieve function allows users to analyze features of interest in an animation with a higher resolution image, and provides the option to dismiss the new image or start a new animation with it. This is done after halting the animation, selecting the expansion-box icon (arrow #1), selecting the resolution size on the retrieval GUI (arrow #2), positioning the wirebox (arrow #3), and selecting "OK" on the retrieval GUI (arrow #2).
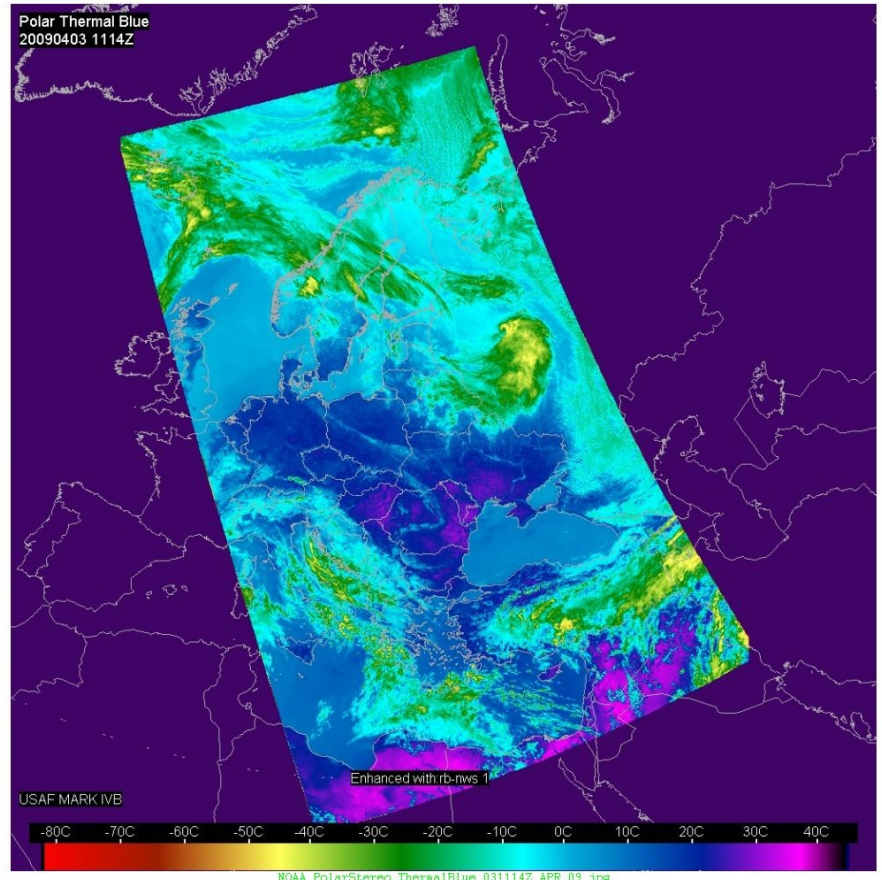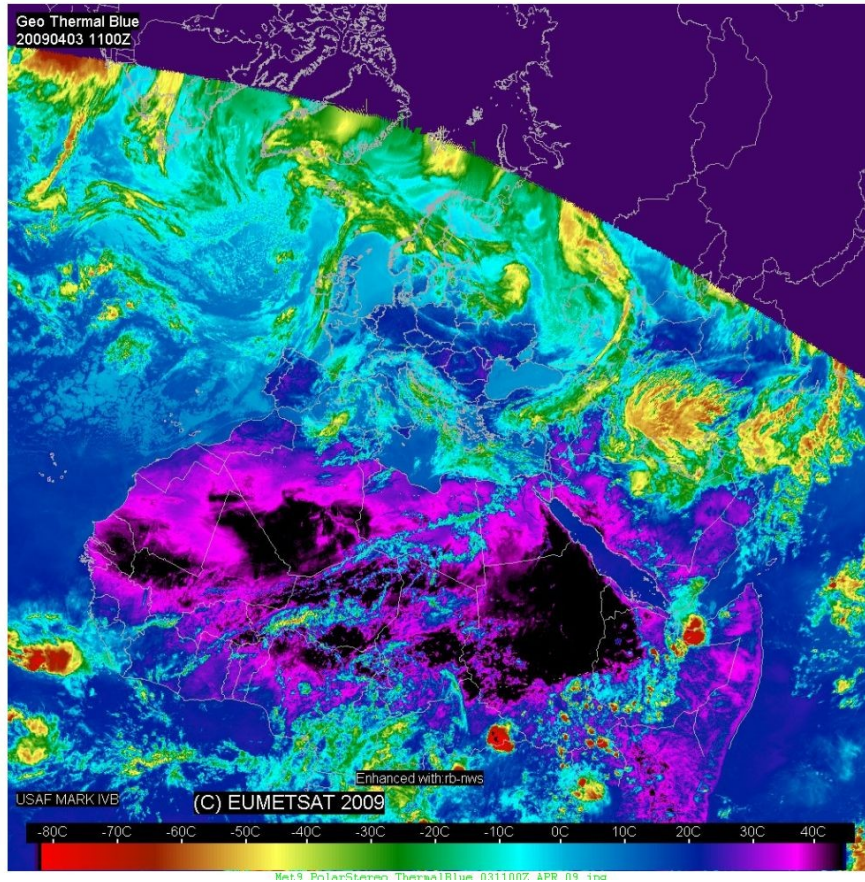
The new servers provide two projected Areas of Interest. AOI #1 is always centered on the local direct readout system for DMSP and NOAA polar satellite collection. The examples above show that the Sembach system has set the ingest system for North Polar Stereographic, which sets the Data Server AOI #1 to the same projection.

Also note the temperature scale has been added to the infrared color annotation bar at the bottom of the images.

Geo Thermal Blue
20090403 1100Z

Geo BB IR
20090403 1116Z
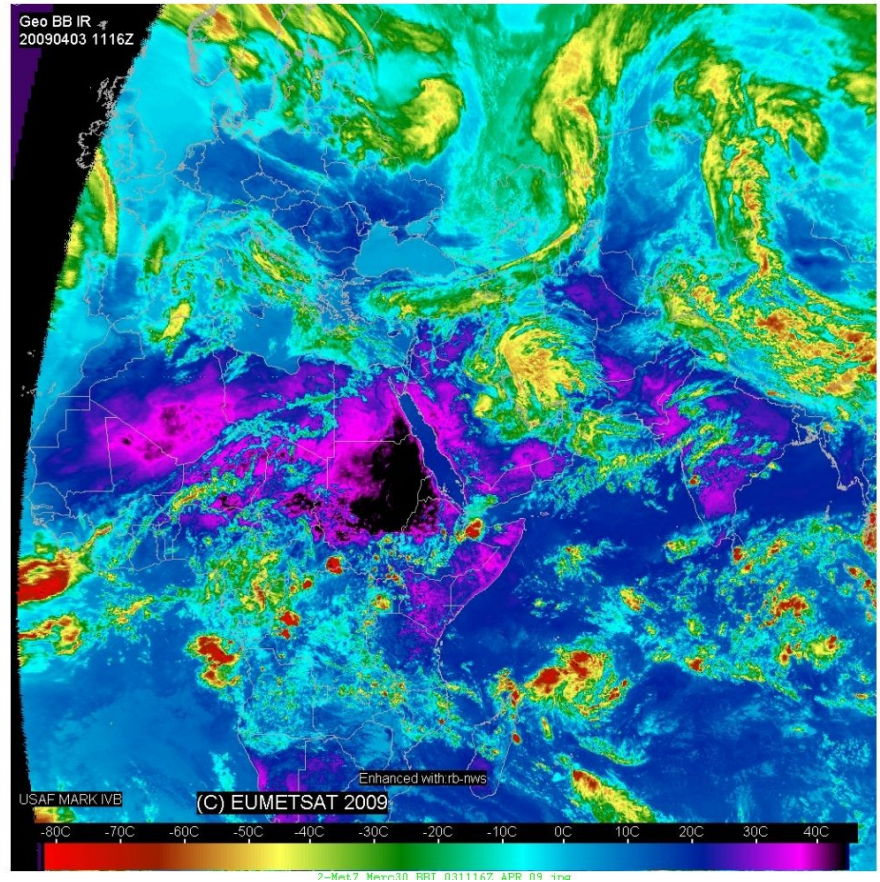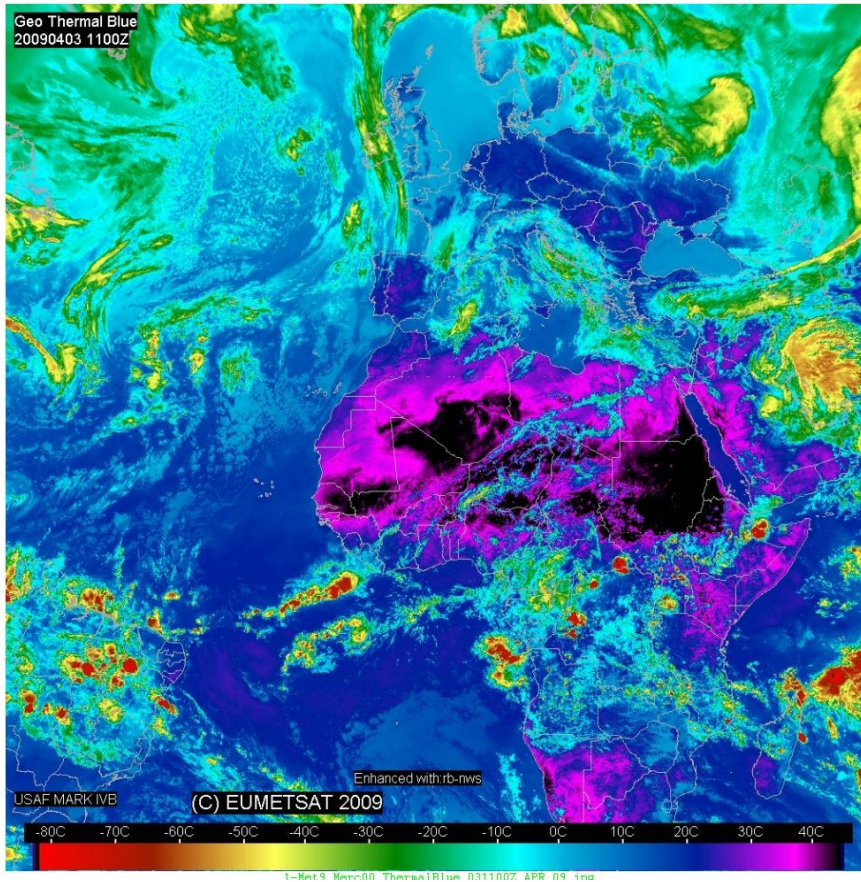
The second AOI on the new servers can be set to Stereographic, Geographic or Mercator, and centered **on a different location**. The Sembach examples above show (left) Data Server #2, AOI #2 is set to 20N 00E or Met-9, and (right) Data Server #1, AOI #2 is set to 20N 40E for Met-7.

Also note that the product/time text in the upper left now has a contrasting background. The previous clients overlaid only text onto the imagery without a text background, and the image colors sometimes made the text hard to read.
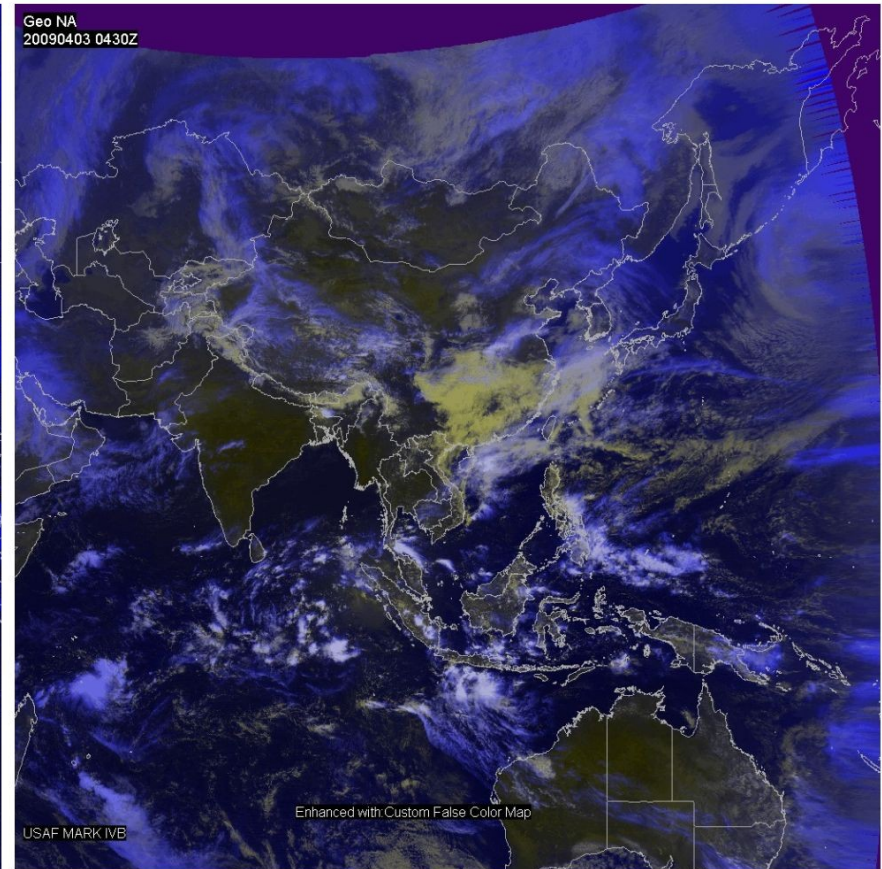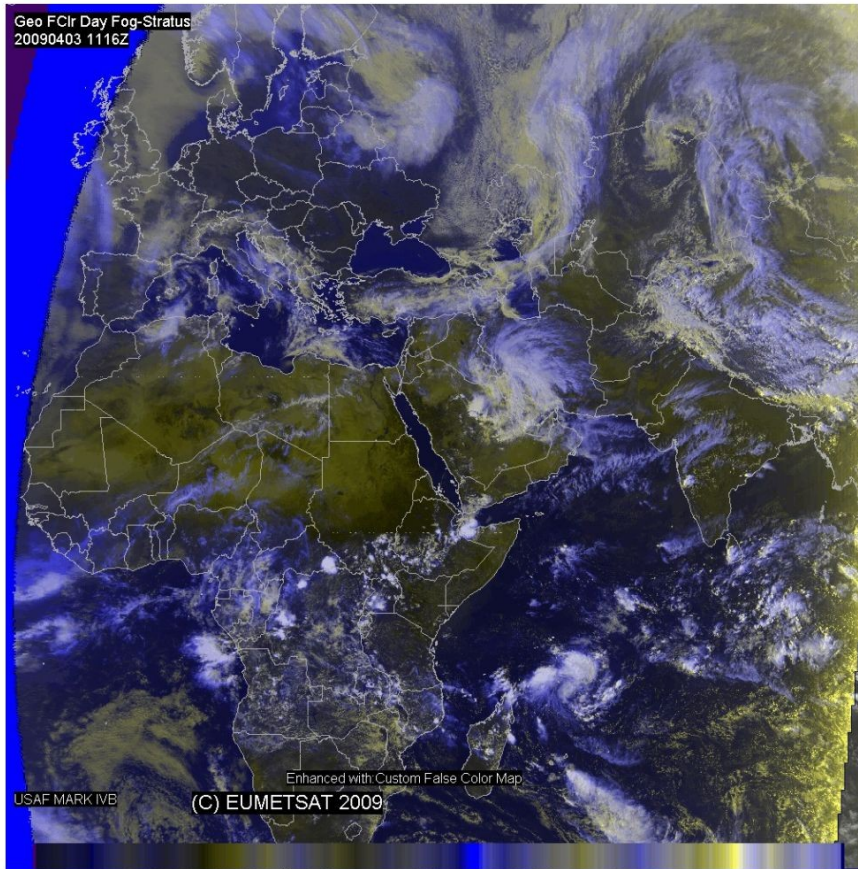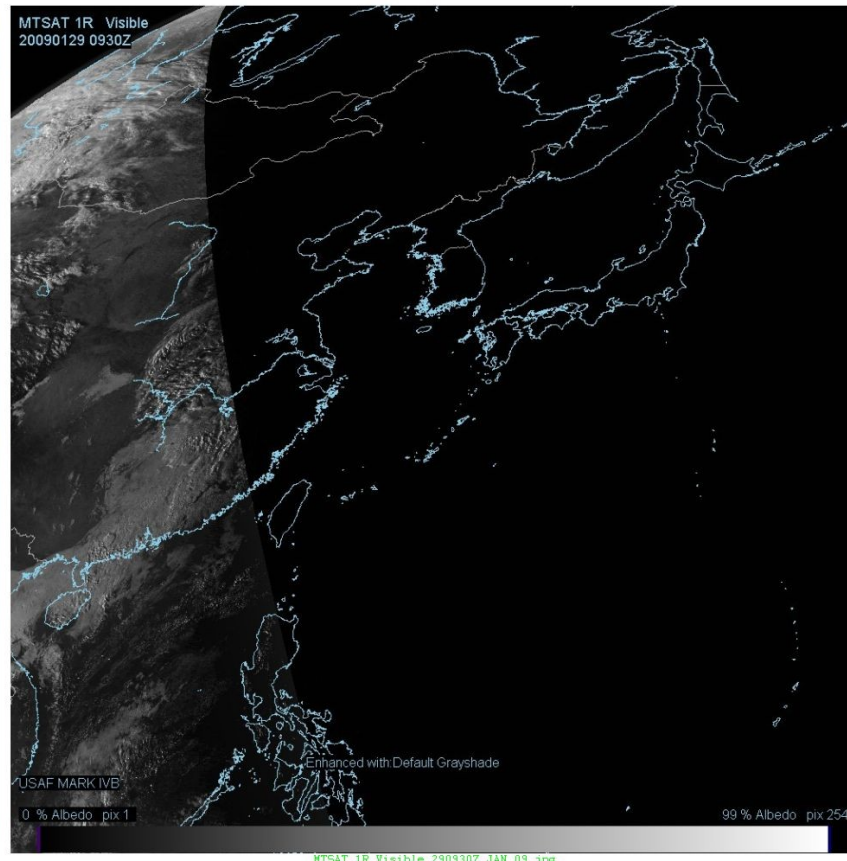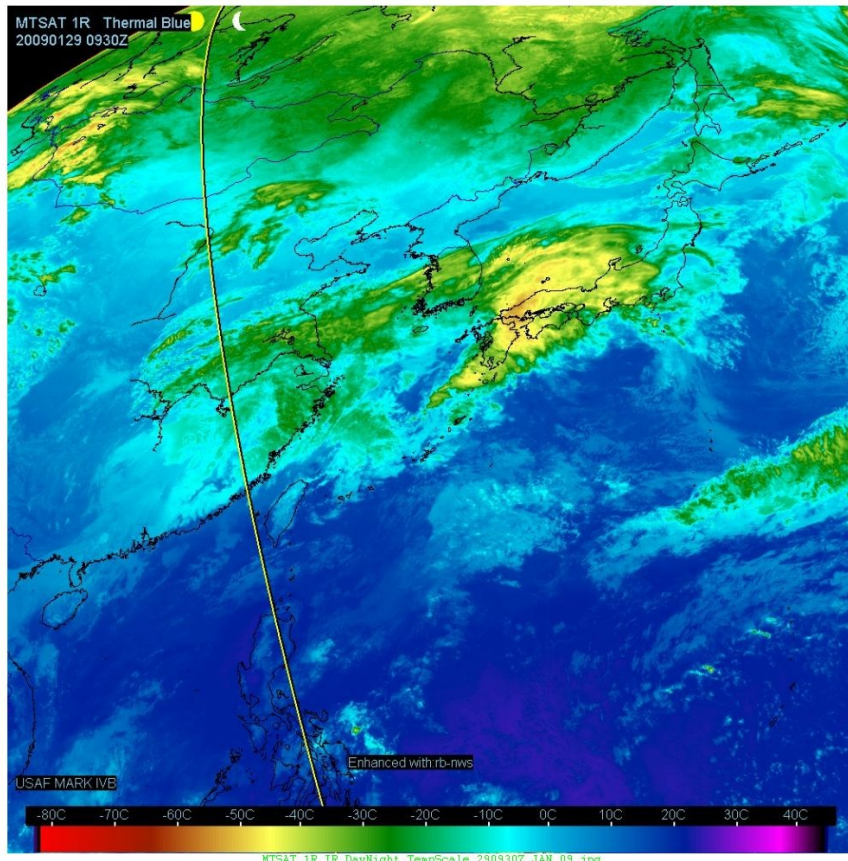
The Data Servers can create projected MSIs. On the left is a Met-7 Day Fog-Stratus MSI from Sembach DS2, AOI #2. On the right is a Day Fog-Stratus MSI manually created from FY-2D projected channels retrieved from the Kadena system. The manually created projected MSI does not have sun angle correction (not available with projected visible images on the client), while the server-built projected MSI does.

The Day/Night indicator line (with Sun and Moon symbols) can be used with all Mark IVB imagery types, but was originally requested for use with Infrared images and animations. Since all times are in Zulu, and infrared imagery users may be half a world away from the imagery area, this tool can be used to indicate when and where GEO or polar visible images and visible-based MSIs are available, rather than pulling a few (or many) preview images.

Also note the enhancement color bar (left image, on the bottom) now offers a temperature scale for thermal infrared, water vapor and microwave imagery.

- ## Contract Modified to Add MetOp
  - ❖ **Currently adding stored 'complete orbit' data at Sembach system**
    - **Described in the following slides**
  - ❖ **Direct Readout capability to be added soon**
    - **AHRPT broadcast requires a firmware upgrade**
    - **Firmware upgrade will facilitate FY-3 series collection**

- ## On contract to upgrade for X-Band modification
  - ❖ **Third antenna being added to current sites**
    - **Required for Aqua and Terra collection**
    - **Will support NPP and NPOESS collection**
    - **Will also collect NOAA and DMSP**
    - **Will reduce single tracking antenna schedule conflicts**
  - ❖ **Developing a two tracking antenna system for new**

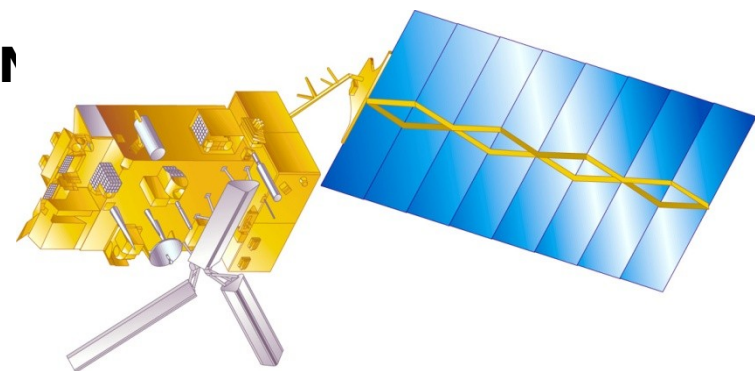- **Part of NOAA-EUMETSAT coordinated POES constellation**
  - ❖ MetOp is now the Primary satellite in the 0930 orbit

- **MetOp has the same Vis/IR imager as N**
  - ❖ The AVHRR/3 6-channel imager
  - ❖ Imagery and multispectrals will be the same

- **Approximate Launch Dates**
  - ❖ MetOp-A: 19 Oct 2006
  - ❖ MetOp-B: 2010
  - ❖ MetOp-C: 2015

- **METOP-A Direct Broadcast failed on 4 July 2007, resumed 29 Sep 2008**
  - ❖ MetOp-A L-Band AHRPT currently limited to Europe and N Atlantic
  - ❖ MetOp B & C AHRPT has been modified and will broadcast globally
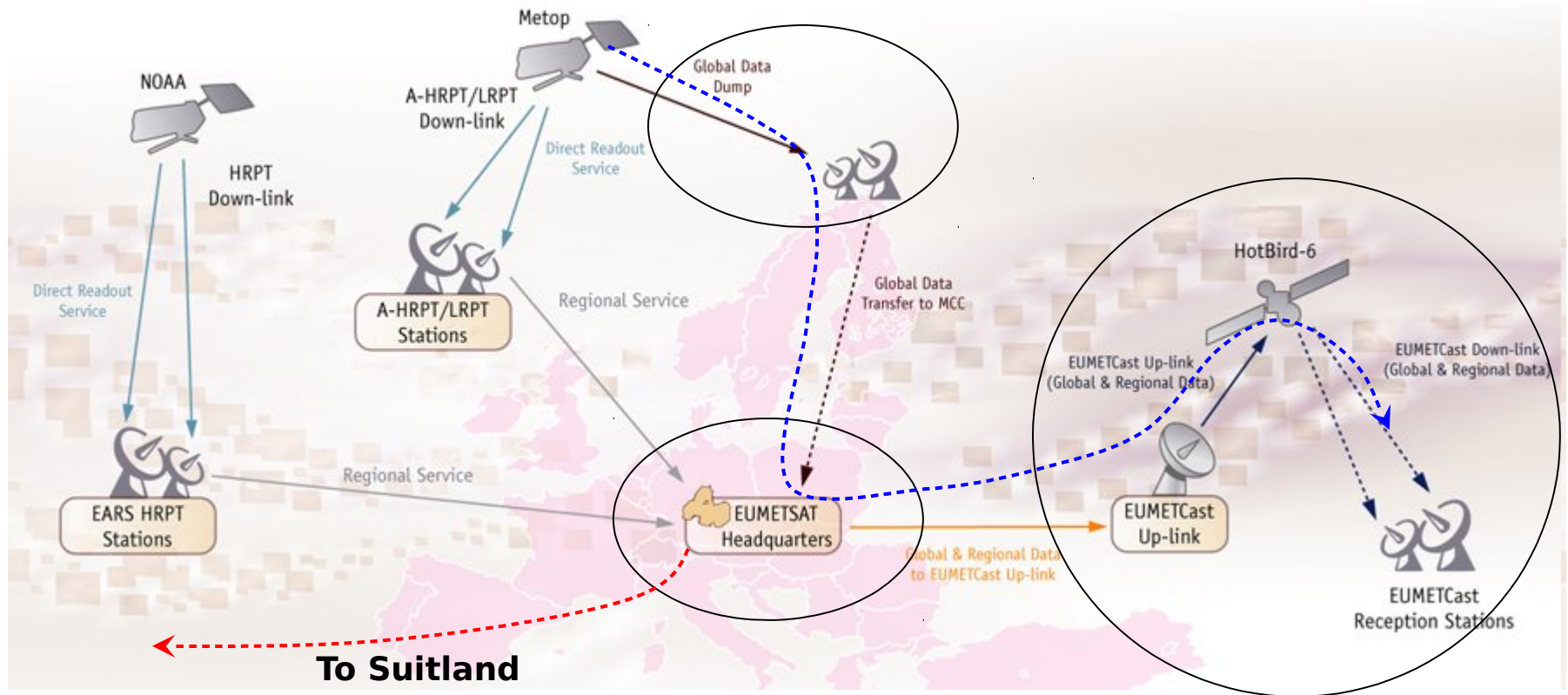
- **Stored data is available vis the EUMETCast system**
  - ❖ Provides data from complete MetOp orbits
  - ❖ MetOp Stored AVHRR is high resolution
  - ❖ NOAA Stored AVHRR (GAC – Global Area Coverage) is lower resolution

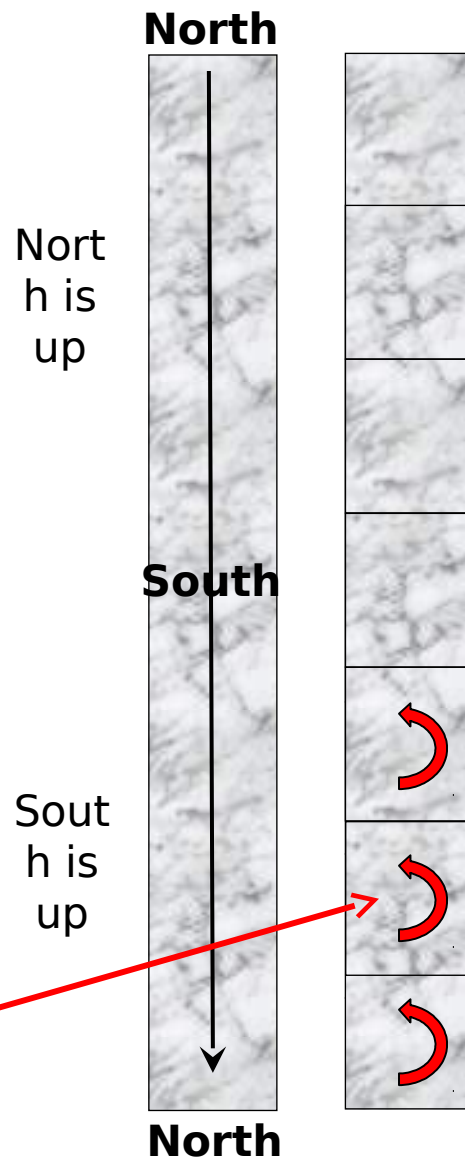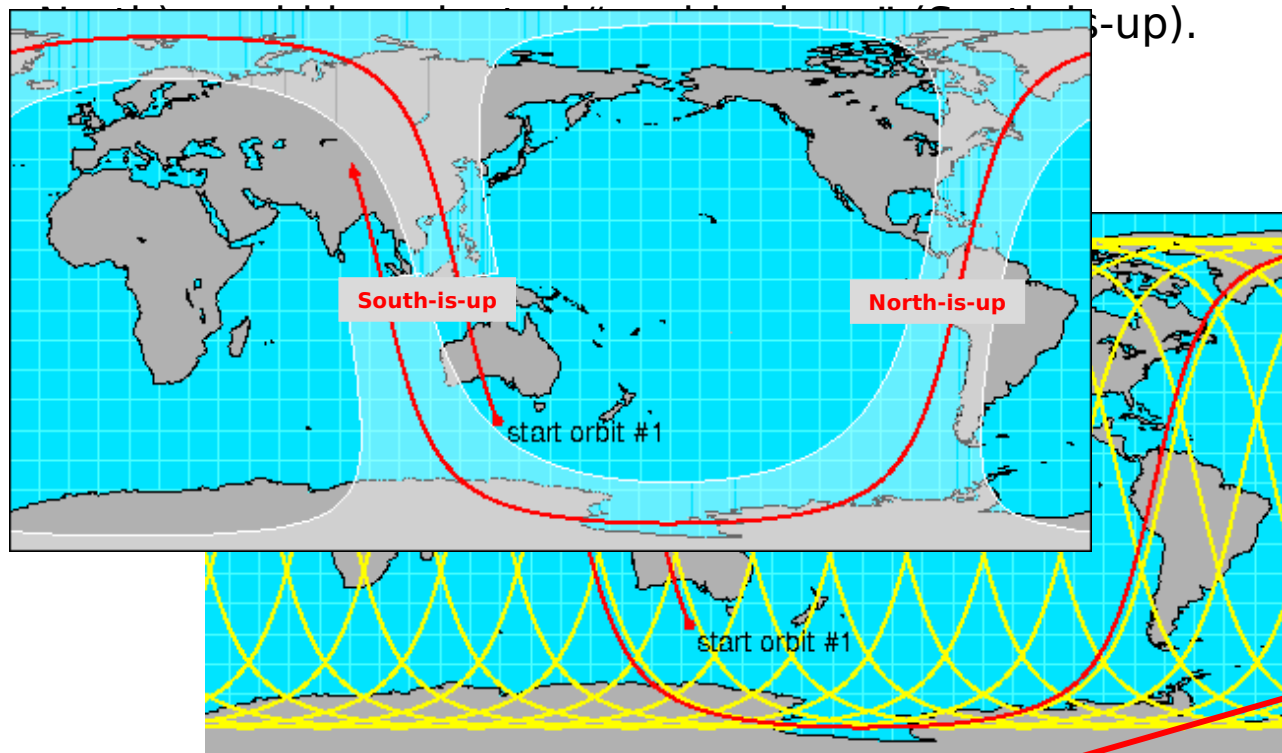# Getting Recorded MetOp AVHRR to Users via EUMETCast

- MetOp-A recorded global data is dumped to the CDAS site at Svalbard, Norway
- Relayed to EUMETSAT Headquarters, in Darmstadt, Germany
- EPS Global Data Service is uplinked to EUMETCast for Europe, via Ku-band
- MetOp stored data is received at the 21 OWS MARK IVB via the EUMETCast receiver

Separate recorded MetOp, DMSP & NOAA data into several North-aligned Segments

A 101 minute orbit is too long to fit into the Mark IVB preview windows or image area, and must be broken into segments
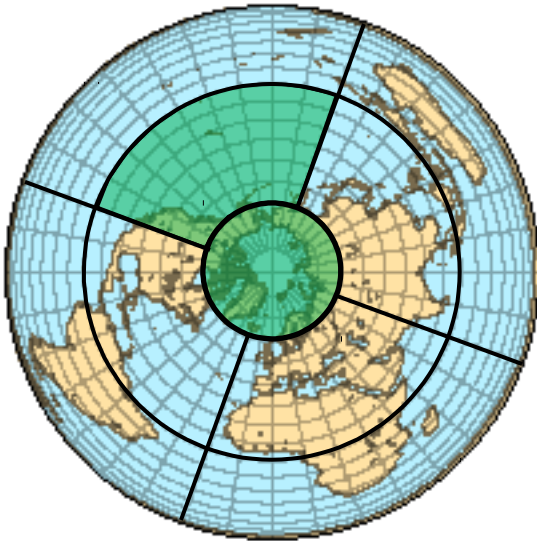
Ascending sections of the orbit (travelling South to ~~North~~) ~~would be oriented "upside down" (South-is-up).~~

North

North is up

South

South is up

North

South-is-up   North-is-up

start orbit #1

start orbit #1

The orbits are broken into <u>North-aligned</u> segments.

Stored MetOp Data Boundaries and Geographic Area Names

Boundaries	Common Names
160E-070E	East Asia
160E-070E	Australia
070E-020W	Europe-N Africa-SWA
070E-020W	South Africa
020W-110W	N America-Atlantic
020W-110W	South America
110W-160E	N Pacific -NW America
110W-160E	South Pacific
66N Circle	North Pole (or Arctic)
66S Circle	South Pole (or Antarctic)

Outliner will have a Stored Folder with Multiple Non-Projected Area Folders

- **Terra and Aqua: both have MODIS**
  - ❖ 36-channel VNIR, SWIR, MWIR, LWIR Spectrometer
  - ❖ Swath width 2330 km
  - ❖ Subpoint Resolution:
    - Two VNIR bands at 250 m
    - Five bands at 500 m
    - 29 bands at 1.0 km
  - ❖ Channel comparisons in slides 19-21

- **Orbits**
  - ❖ Terra: 1030L Descending
  - ❖ Aqua: 1330L Ascending
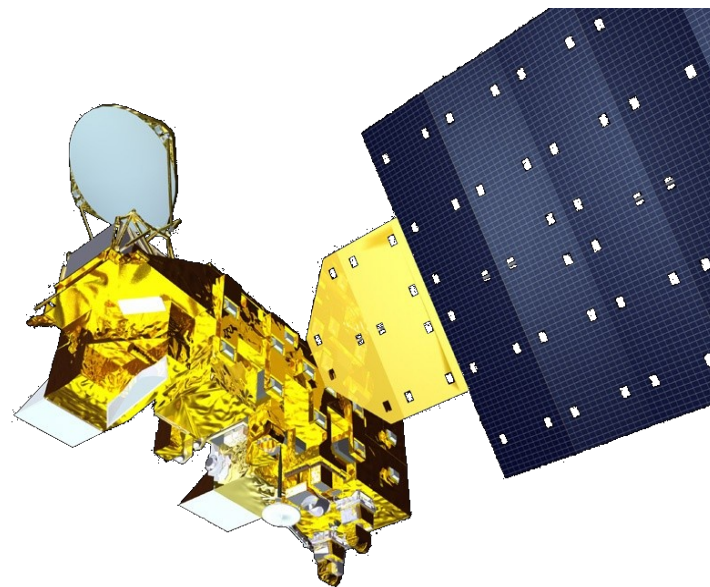
RSS Upgrade - AN/UMQ-13 (V)2
Two-Dome System
Polar-only

Radome w/Lightning Rod & Hazard Lights

X/L/S-Band 3 m Tracking Antenna

L/S-Band Tracking Antenna

Radome

Half-Rack w/SDAS Equipment

Environmental Control Unit

Conduit for Fiber Optic Cable
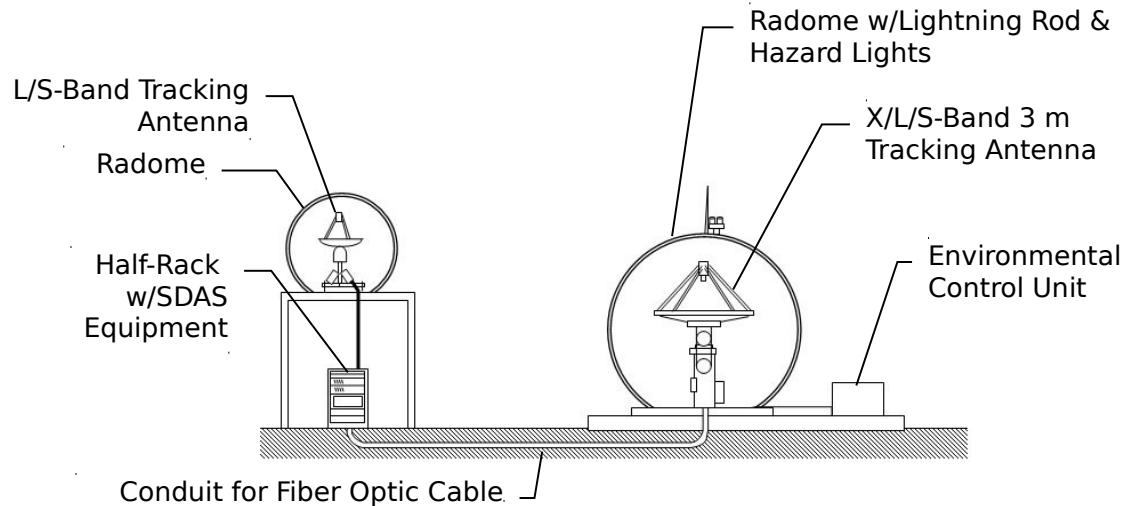
Al Udeid – Tentative Oct 2009

AN/UMQ-13 Three-Dome Site
One Geo - Two Polar or
Two Geo - One Polar

Existing 10 ft Tracking Antenna

Equipment racks)

Existing 17 ft Pointing Antenna

Radome w/Lightning Rod & Hazard Lights

X/L/S-Band 3 m Tracking Antenna

Tower w/Staircase

Conduit for Fiber Optic Cable

Environmental Control Unit*
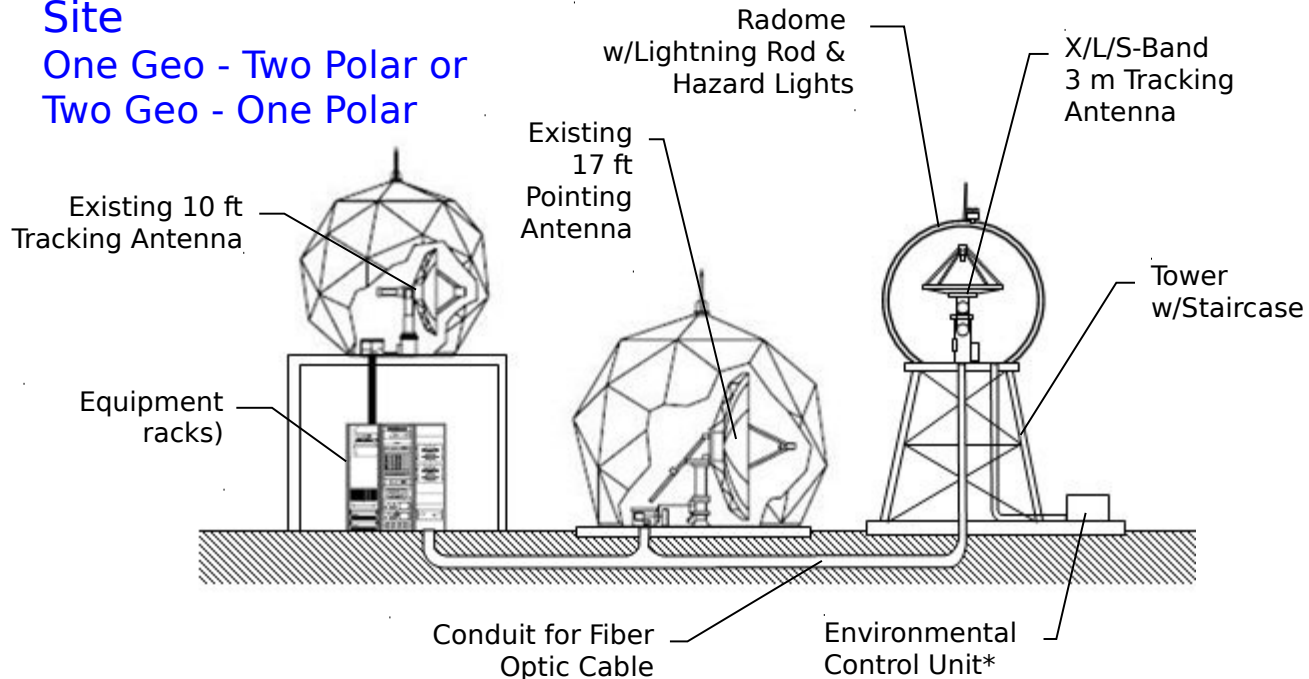
Elmendorf AFB Alaska – Nov 2009???
Kadena AB Okinawa – 2QFY2010
Sembach / Kapuan Germany – 2Q/3QFY 2010
Andersen Guam - 4QFY2010
Hickam Hawaii - 4QFY2010

A Few Multispectral Examples

Stratus in the Tropics and Sheared Tropical Cyclones at Night

There are some problems with infrared imagery. **Longwave infrared** imagery may not clearly show **low clouds** near **weak or sheared** tropical cyclones, and color enhancements that target stratus may not highlight these clouds clearly.

Low clouds may have temperatures similar to the sea surface and provide a poor contrast. Low clouds may also have a poor contrast with nearby thin cirrus, which can be contaminated/mixed with warmer emissions from the sea surface below. Also, tropical water vapor partially attenuates the emissions of stratiform clouds.

The longwave-midwave infrared channel difference is used to create a **night fog stratus** (MFS) product, which is colorized with an enhancement table, but the enhancement is **designed for highlighting fog and stratus in mid-latitude** continental regimes with smaller cloud droplets and less water vapor.

The Naval Research Labs has a modified channel difference product that accounts for the differences due to the larger maritime cloud droplets and higher water vapor values. The channel difference is the same as the MFS, but the range from -3 to +3 is stretched to highlight the ocean surface features and stratus better.

Standard server multispectral images (MSIs), such as the IR Fog (FIF) may highlight nighttime features to help monitor storm environment and changes. Other recently developed MSIs **are not yet added** to the server, but **may be built on the client with recorded functions**.

False color MSIs are red-green-blue composites constructed from two or more different parts of the visible-infrared spectrum. The most common false color is a two-channel false color that uses visible imagery in the red and green video inputs, and an LWIR image in the blue input.

The atmosphere absorbs energy at some wavelengths (absorption-emission bands) and allows energy at other wavelengths to travel downward and upward with minimal absorption (atmospheric windows).
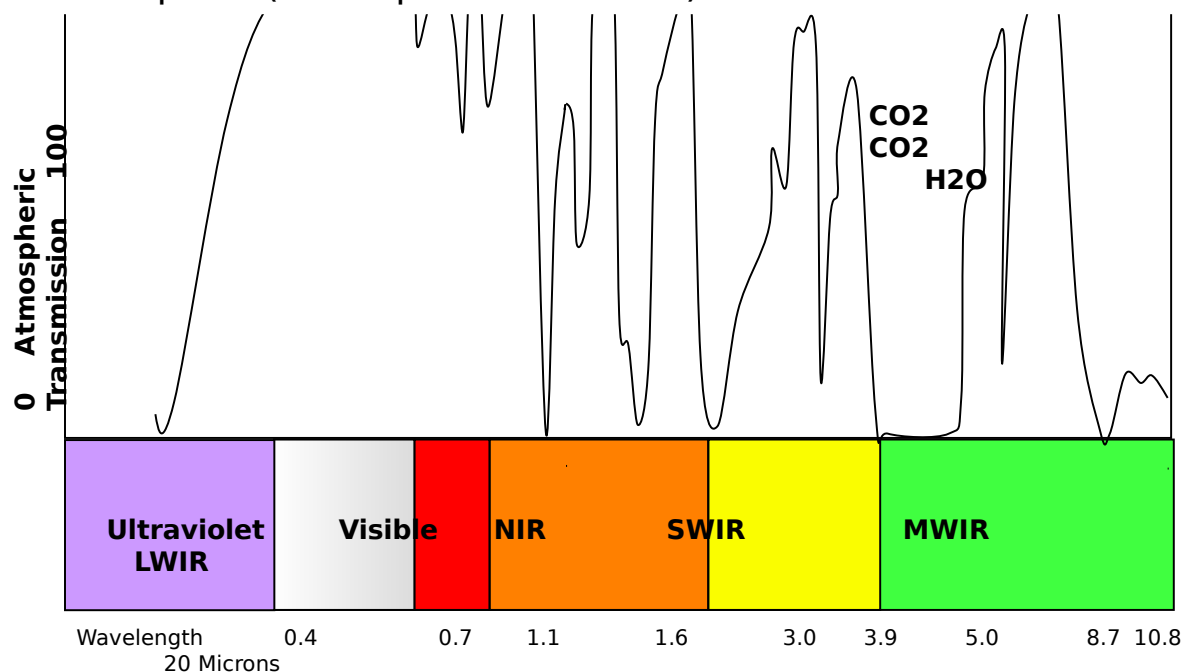
These are the parts of the spectrum measured by METSAT imagers, and their MARK IVB channel names.

| Microns	IR Bands	MARK IVB names
0.6	Visible	Visible
0.8 or 1.1	NIR	Near IR
1.6	SWIR	Snow-Cloud
3.7 or 3.9	MWIR	Low Cloud
6.2 or 6.7	H2O	High Water Vapor
7.3	H2O	Mid Water Vapor
8.7	LWIR	Cloud Phase
9.7	O3	Total Ozone
10.8	LWIR	Thermal Blue
12.0	LWIR	Thermal Red
13.4	CO2	CO2 Absorption

NIR   = Near Infrared
SWIR = Shortwave Infrared
MWIR = Midwave Infrared
LWIR = Longwave Infrared

Longwave IR and Water Vapor

MTSAT-1R 20070830 1538Z 10.8 micron Longwave IR (left) and water vapor imagery (right) images of TC 10W, Typhoon Fitow with with BD (left) and Rainbow (right) enhancements.
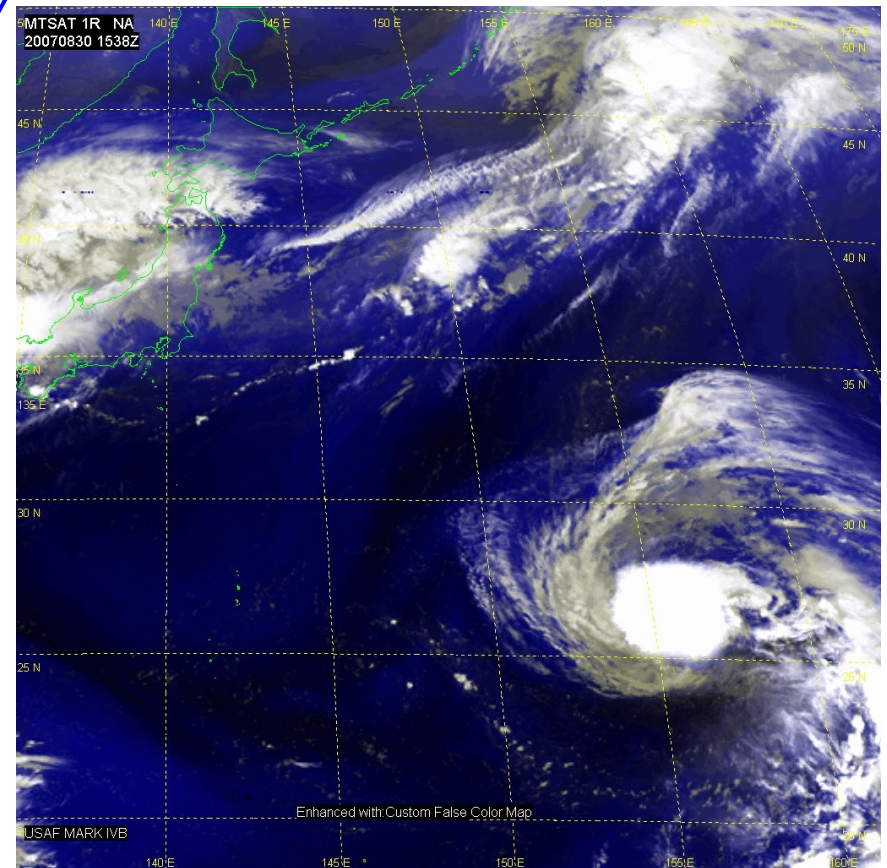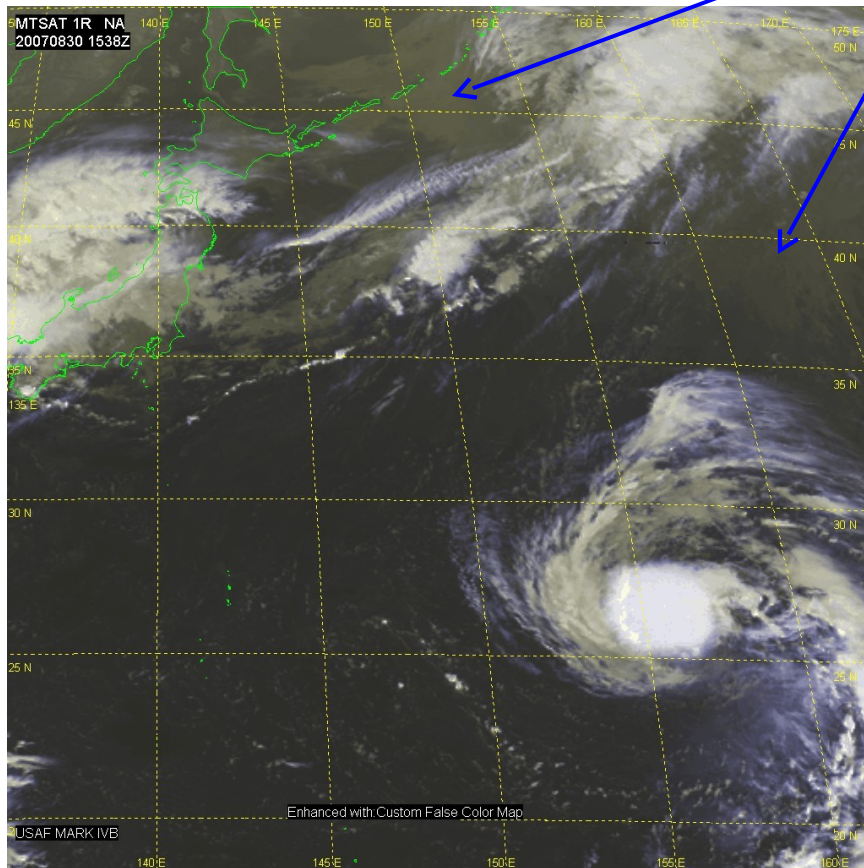
With experience, one can tell with the BD enhancement that there are areas of stratus North of Typhoon Fitow. The ocean to the West has some cumulus, but
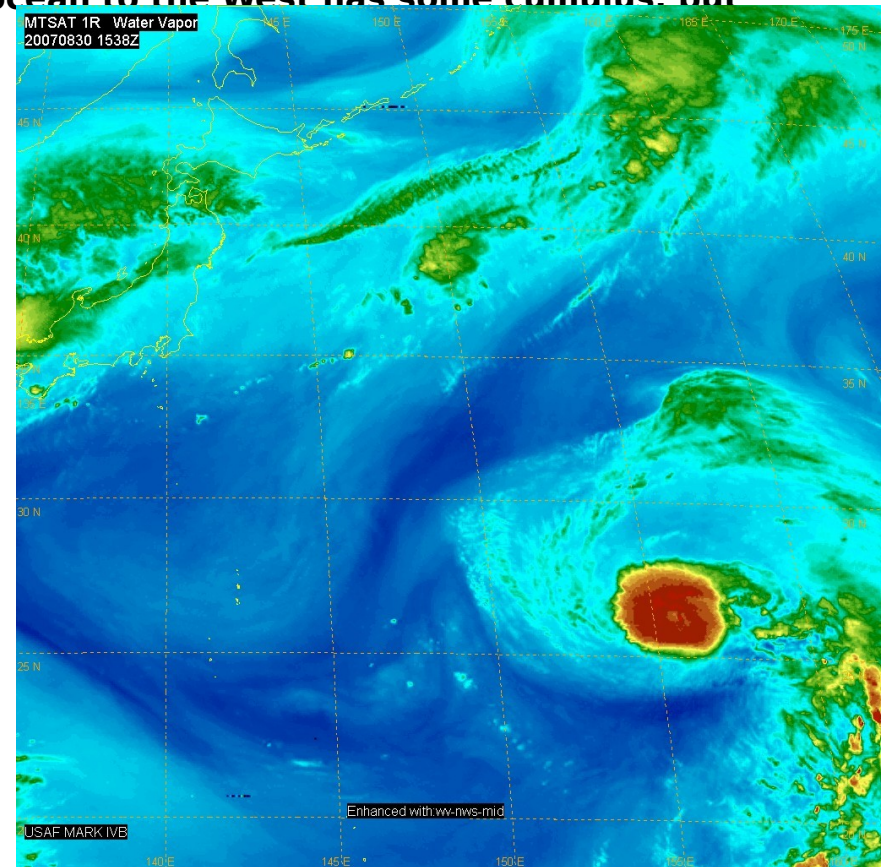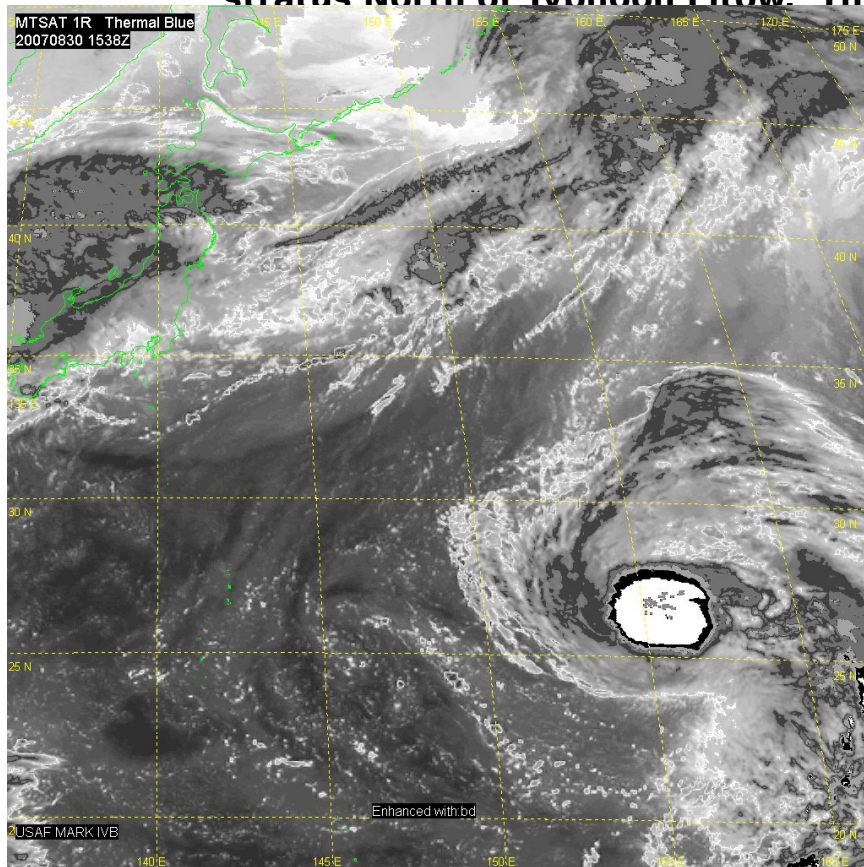
JTWC FJT and FJW MSIs

The LWIR - MWIR JTWC Tropical false color (FJT) on the left, and the LWIR - Water Vapor (FJW) at right show high and mid level clouds, while the FJW also shows areas of abundant upper level water vapor. One can see hints of low clouds to the North in the FJT image.
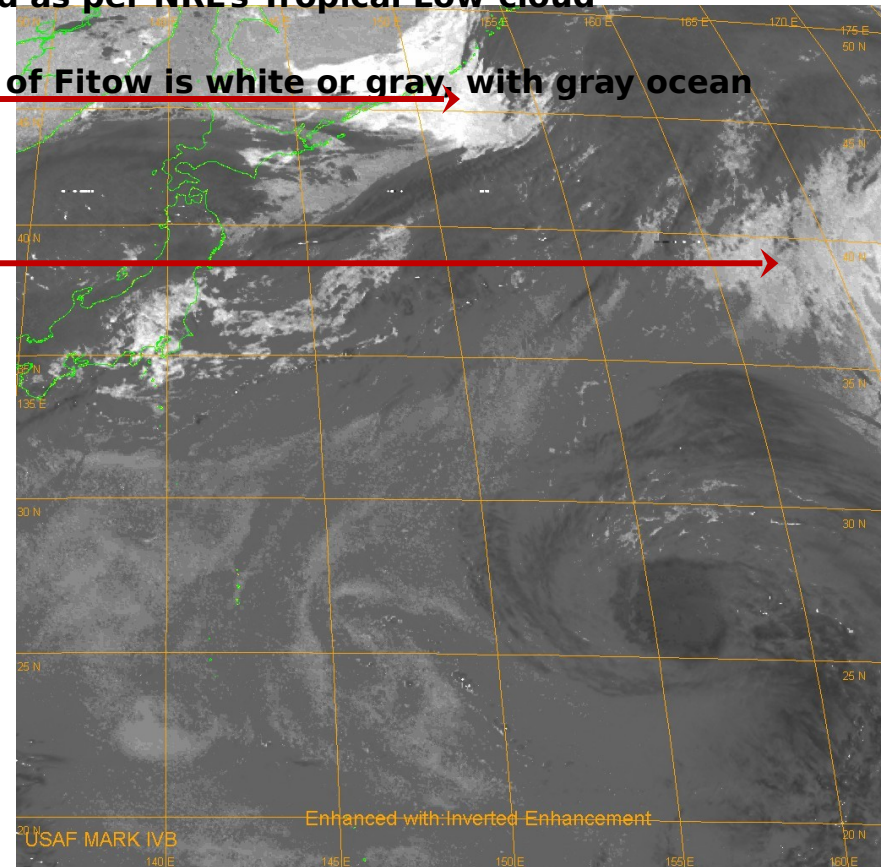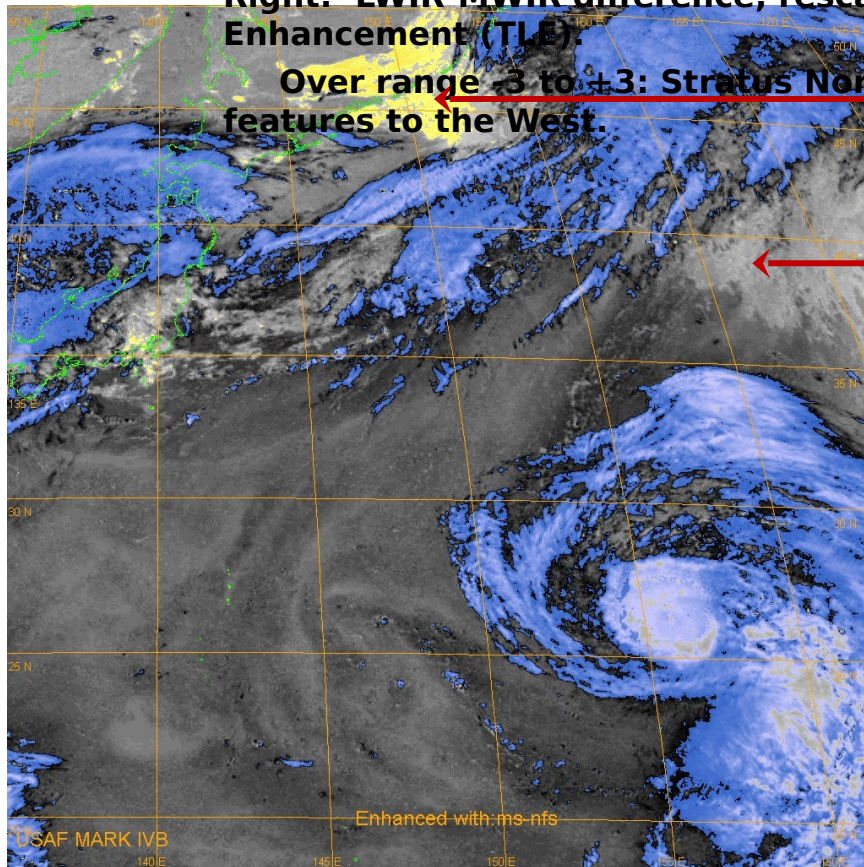
Left: LWIR-MWIR difference with the MARK IVB 'Night Fog-Stratus' color enhancement (MFS).

Stratus colored yellow over range of 0 to +3, cirrus in blue, and greay ocean features to the West.

Right: LWIR-MWIR difference, rescaled as per NRL's Tropical Low-cloud Enhancement (TLE):

Over range -3 to +3: Stratus North of Fitow is white or gray, with gray ocean features to the West.
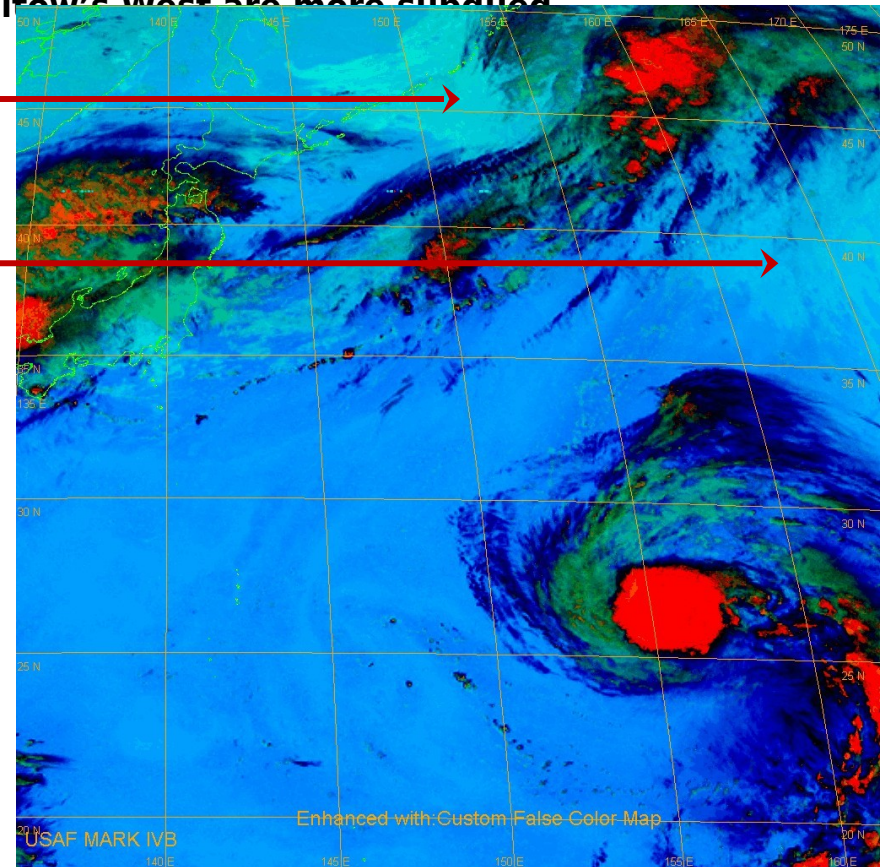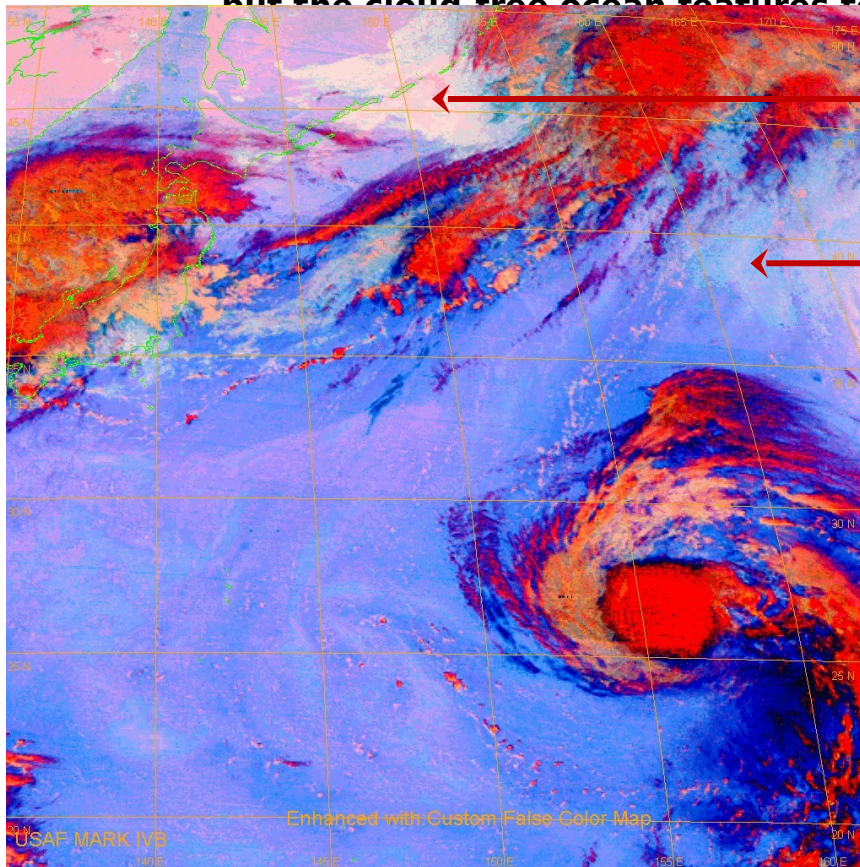
Updated IR Fog MSIs
FIF and FF3

The updated IR Fog (FIF) is shown on the left with the updated IR FogN (FF3) at right.

The two areas of stratus North of Typhoon Fitow are highlighted, and mid and high level clouds are presented clearly better than the MFS and TLE products, but the cloud free ocean features to Fitow's West are more subdued.

Mark IVB multispectral products are usually built on the server when users request the products.   The Mark IVB 11.10.0205 and 11.10.0303 upgrades include the modification to the FIF (IR Fog) MSI.

The other MSIs are not included in this upgrade cycle, but users can also build MSIs on the Mark IVB client application.

Mark IVB client users can obtain recorded functions and save them to the function directory. Once the functions have been saved there, they are available for use with downloaded imagery.

The new functions are:
     Convert_MFS-to-TLE.ftn
     GeoWV-IR_NightMSI.ftn
     NewIR-Fog_FIF-FF3-TLE.ftn

The default location for the functions directory is: C:\documents and settings\m4b_data\dat\commands\

NOTE: Mark IVB client users can define their preferred data directories to different folders, or a different local drive or a shared network drive.

1. The "Convert_MFS-to-TLE" function requires the MFS (Night Fog Stratus) product in work area 1.

2. The "GeoWV-IR_NightMSI" function requires the user load Water Vapor and Thermal Blue images into work areas 1 and 2, respectively.

3. For the "FIF, FF3, and TLE" function, imagery must be loaded in work areas 1, 2, 3 and 4 in this order:

GOES, FY-2, and/or MTSAT		Creates these Night-onlyMSIs
Low Cloud (LCL)	FF3	IR FogN
Water Vapor (WVr)	FIF	IR Fog
Thermal Blue (Blu)	FJT	Tropical Environment
Thermal Red (Red)	MFS	Night Fog-Stratus
	TLE	Tropical Low cloud Enhancement

After the images are loaded, then the user selects the NewIR-Fog_FIF-FF3-TLE function.

NOTE #1: Meteosat-7 does not have the low cloud (MWIR) or split window (Thermal Blue and Red) channels necessary for the FIF, FF3, FJT, MFS or TLE MSIs.

NOTE #2: Meteosat-7 and all other GEOs can be used to build the FJW MSI, day or night.

NOTE #3: Once any function is used, you can get to it faster by right-clicking on the Function icon for a pop-up list of the most recently used functions for a frequent use.